

AAON®

Heating & Cooling Products

marketing memo

To: All AAON Sales Representatives

October 1, 2001

NEW PROMOTIONAL LITERATURE

The RL Series 40 to 230 Tons for Air Cooled, Evaporative Cooled or Water Cooled

Enclosed with this memo are 50 copies of the new RL Series full color promotional literature. Read this over completely. Get ready for the two RL product sessions that will be held here in Tulsa this month to answer all your questions.

Notice the photo on page 2 is an air cooled unit being built in the West Tulsa plant. The centerfold of product features also shows those taken of evaporative cooled models, as well as, many of the common features of all the models.

RL Product Hi-Lites

In this session you will see a complete evaporative cooled unit. All of the features will be reviewed in a unique manner that you will be able to "take home with you" in your pocket. You will not forget this presentation.

RL Software

The RL product has many of the features that you always expect from AAON. It also will have new and unrivaled features that you must learn how to select and use to our best advantage. The RL software will be extensively demonstrated in this session. With the RL Series you have fan options that will be presented to you by the software, with the corresponding sound levels.

The Unit Rating sheet gives you all the performance information you need including sound information.

The overall dimensional drawing of the selection will also be an output of the software. No guessing or waiting to get information back from the factory to get the customer the dimensional data they always want immediately.

Get your questions ready - Don't miss any of the RL sessions. We look forward to seeing you at the Sales meeting.



Jim Parro
Marketing Manager

AAON INC.

2425 S. YUKON, TULSA, OK 74107 918-583-2266

INVOICE

PLEASE REMIT TO:

AAON, INC. DEPT 563 TULSA, OK 74182

INVOICE NO. 265184

CUSTOMER NO. 848635

INV. DATE 02/28/02

PAGE 1

CUST. P. O. NO. A-0440

SOLD TO
TOBEY-KARG SALES AGENCY
4640 CAMPBELLS RUN ROAD

PITTSBURGH, PA 15205
USA

SHIP TO
WEIRTON MED CTR
C/O SCALISE INDUSTRIES
601 COLLIERS WAY
WEIRTON, WV 26062
USA

SALES ORDER NO. 254862	TERMS NET 30 DAYS	CUSTOMER JOB NO. WEIRTON MED CTR.	SHIP ZONE WV
SHIP VIA MELTON	F.O.B. POINT TULSA OK	SHIP DATE 02/28/02	VENDOR# & CUSTOMER
BILL OF LADING NO. 244341 - 244555	FINAL DESTINATION 414		

ITEM NO.	QUANTITY SHIPPED	DESCRIPTION	UNIT	PRICE	EXTENSION
1	2	2/5 PER REP(DEBBIE) OK TO SHIP 2/19. JL TAX % s SUBJECT TO CHANGE 38221	EA	94,890.910	189,781.82
2	1	RL-155-3-0-AB06-000: HGCLE00GB10B0JAAC00H000A000000X FREIGHT	EA	4,600.000	4,600.00
		SUBTOTAL			194,381.82
		TAX (0.000%)			0.00
		DISCOUNT- 20 DAYS PAYMENTS RECEIVED 20 DAYS FROM INVOICE DATE \$ 1,897.81			
		INTEREST-1.5% PER MONTH CHARGED BEGINNING 30 DAYS AFTER INVOICE DATE \$ 2,915.72/mo.			
		>>> PAYMENT IN U. S. DOLLARS <<<			
		TOTAL			\$ 194,381.82

REPRINT OF ORIGINAL

CL 339

AAON, Inc.

Order Form

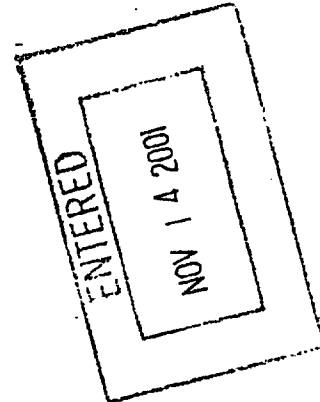
2025 South Yukon Ave • Tulsa, OK 74107 • Ph: (918) 583-3206 • Fax: (918) 583-5064

Tobey-Karg Sales Agency 4840 Campbells Run Rd Pittsburgh, Pa. 15206 USA		Date: 11/19/2001 Page 1 of 1	
Weirton Medical Center 801 Colliers Way Weirton, W.Va. 26062 USA		Job Name: Weirton Medical Center Customer P.O. #: 348633 Job No.: AAON-Genet Shop Order #: 778 Rep #2: Action: Release To Production Ship: ALLOWED Notify: Joe Sealise 48 Hours Before Delivery @ Phone No: 1-724-746-4400 Marketing Code: Shipping Zone:	

Qty	Part #	Description	Unit Net Ex.	Ext. Price
2		RL-166-3-0-AB06-000:HGC1-E00-QB1-0B0-JAAC00H-00-0A000000B CFM: 62000 ESP: 2.0"	\$94,890.91	\$189,781.83
Rep Contact: Creed Hess			Total List Price \$: \$902,462.00	
Ordered By: Creed Hess			Total Net (Rep. Cost) \$: \$189,781.80	
			Freight \$: \$0.00	
			Commission \$: \$0.00	
			Total Billing \$: \$189,781.83	

*Total Billing Amount Does not include any Applicable Local or State Taxes

197,981.80



10/21/11

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N.Y.

Handcock
11/14

SHIP ON 2/11/02

AAON, Inc.**Worksheet**

2426 South Yukon Ave - Tulsa, Oklahoma 74107-2728 - Ph. (918) 583-2266 Fax (918) 583-4094

AAONEst32 Ver. 4.00 Beta

RL-155-3-0-AB06-000:HGC1-E00-QB1-0B0-JAAC00H-00-0A000000B
Tag: RTU#1,2Job Name:
Job Number:Winton Medical Center
Job #1Worksheet For:
Worksheet Date:Tobey-Karg Sales Agency
November 19, 2001

R	Base Option	Description	List Price	Rep. Price	Cust. Price
L	Series	Roof Top Unit			
155	Generation	Right's Generation			
3	Size	One Hundred and Fifty Five			
0	Voltage	480V/3Ø/60Hz			
0	Interior Protection	Standard	\$0.00	\$0.00	\$0.00
A	Cooling Style	Draw Thru-R22 Dual Circuited Compressors	\$0.00	\$0.00	\$0.00
B	Cooling Configuration	Air Cooled Cond w/ 6R coil High CFM	\$5461.00	\$1721.16	\$1721.16
0	Cooling Coating	Std	\$161733.00	\$47795.89	\$47795.89
6	Cooling Stages	Std	\$0.00	\$0.00	\$0.00
0	Heating Type	5 Stage	\$1680.00	\$529.20	\$529.20
0	Heating Designation	No Heat	\$0.00	\$0.00	\$0.00
0	Heating Stages	No Heat	\$0.00	\$0.00	\$0.00
			\$0.00	\$0.00	\$0.00

H	Feature Option	Description	List Price	Rep. Price	Cust. Price
G	1A. Outside Air Options	Rest Wheel Small (S) (1-74 inch wheel)	\$37931.00	\$11046.25	\$11949.26
C	1B. RA Blower Configuration	2 Blowers (Prem off mtr) w/ 2-motors 2-VFD	\$12467.00	\$3927.10	\$3927.10
1	1C. RA Blower	Blower C (42" Dia 12 Blade)	\$3524.00	\$1110.06	\$1110.06
E	1D. RA Motor	25.0 hp (1760 rpm)	\$6824.00	\$1992.08	\$1992.08
0	2. Outside Air Controls	DDC Neon Control	\$4886.00	\$1532.09	\$1532.09
0	3. Discharge Location	Bottom Discharge	\$0.00	\$0.00	\$0.00
0	4. Return Location	Bottom Return	\$0.00	\$0.00	\$0.00
Q	5A. SA Blower Configuration	4 Blowers w/ (Prem off mtr) w/ 4-VFD's	\$25115.00	\$7911.22	\$7911.22
B	5B. SA Blower	Blower B (30" Diameter)	\$7904.00	\$2489.78	\$2489.78
1	5C. SA Motor	25.0 hp (1760 rpm)	\$12648.00	\$3984.12	\$3984.12
0	6A. Pre-Filter	2" Pleated	\$0.00	\$0.00	\$0.00
B	6B. Final Filter	12" Cartridge 85% Eff. Filter Box B	\$15730.00	\$4954.95	\$4954.95
0	6C. Filter Options	Std	\$0.00	\$0.00	\$0.00
J	7. Refrigeration Controls	6 MTDR On & Off + 20 STDR + 115V Outlet Factory	\$1405.00	\$442.57	\$442.57
A	8. Refrigeration Options	Hot Gas Bypass Load Stage (HGB)	\$4870.00	\$1876.55	\$1876.55
A	9. Refrigeration Accessories	Sight Glass	\$1700.00	\$535.50	\$535.50
C	10. Power Options	500 Amps Power Switch	\$8770.00	\$1187.55	\$1187.55
0	11. Safety options	Std	\$0.00	\$0.00	\$0.00
0	12. Controls	Std	\$0.00	\$0.00	\$0.00
H	13. Special Controls	Field Installed DDC Controls by Others	\$0.00	\$0.00	\$0.00
0	14A. Pre-Heat Configuration	Std (No Preheat)	\$0.00	\$0.00	\$0.00
0	14B. Pre-Heat Sizing	Std (No Preheat)	\$0.00	\$0.00	\$0.00
0	15. Option Boxes	Std	\$0.00	\$0.00	\$0.00
A	16. Cabinet Options	Stainless Steel Union Pans	\$4680.00	\$1445.55	\$1445.55
0	17. Cabinet Options	Std	\$0.00	\$0.00	\$0.00
0	18. Chiller Code	Std	\$0.00	\$0.00	\$0.00
0	19. C-1's Options	Std ETL USA Listing	\$0.00	\$0.00	\$0.00
0	20. Unit Splits	Std (One Piece Unit)	\$0.00	\$0.00	\$0.00
0	21. Pump & Water Condenser	Std (No Evap or Water Condenser)	\$0.00	\$0.00	\$0.00
0	22. Blank	Std	\$0.00	\$0.00	\$0.00
B	23. Type	Std (Includes 'Crav Print')	\$0.00	\$0.00	\$0.00
	Subtotal		\$301,241.00	\$94,820.91	\$94,890.91
	Quantity		2		
	Total		\$602,482.00	\$189,781.83	\$189,781.83

AAON, Inc.**Unit Rating**

3425 South Yukon Ave. - Tulsa, Oklahoma 74107-3728 - Ph. (918) 583-2285 Fax (918) 583-0084

AAONZEat32 Ver. 4.00 Beta

RL-155-3-0-AB06-000:HGC1-E00-QB1-0B0-JAAC00H-00-0A000000B
 Tag: RTU# 1,2

Job Information

Job Name: Weirton Medical Center
 Job Number: Job #1
 Site Altitude: 0 ft

Unit Information

Unit Size: One forty five tons —
 Cabinet Size: D
 Approx. Op./Ship Weights: 31366 / 31184 lbs.
 Supply CFM/ESP: 52000 / 2.5 in. wg.
 Exhaust CFM/ESP/TSP: 41000 / 1.30 / 2.78 in. wg.
 Outside CFM: 11500
 Ambient Temperature: 92 °F DB / 75 °F WB

Static Pressure

External: 2.50 in. wg.
 Evaporator: 0.94 in. wg.
 Filters Clean: 0.68 in. wg.
 Dirt Allowance: 0.35 in. wg.

Economizer: 0.21 in. wg.
 Heating: 0.00 in. wg.
 Cabinet: 0.59 in. wg.
 Heatwheel: 1.30 in. wg.
 Total: 6.57 in. wg.

Cooling Section

	Gross	Net
Total Capacity:	1585.76	1369.62 MBH
Sensible Capacity:	1209.04	992.00 MBH
Latent Capacity:	376.72 MBH	
HW Total Cooling Capacity:	6.87 °F MBH	
Mixed Air Temp:	75.00 °F DB	64.00 °F WB
Entering Air Temp:	75.00 °F DB	64.00 °F WB
Lv Air Temp (Coil):	53.71 °F DB	53.64 °F WB
Lv Air Temp (Unit):	57.54 °F DB	55.20 °F WB
Supply Air Fan:	DT - 4 x 300 @ 19.98 BHP Ea.	
SA Fan RPM/Width:	1580 / 99%	
Exhaust Air Fan:	2 x MW4212-35 @ 19.19 BHP Ea.	
EA Fan RPM:	1500	
Evaporator Coil:	86.8 ft ² / 6 Rows / 12 FPI	
Evaporator Face Velocity:	599.0 fpm	
Energy Recovery Wheel:	1 x ERC-7490	

Heating Section

PreHeat Type: Std (No Preheat)
 Heating Type: No Heat

EER - ARI Listing Information

No ARI Rating Program Exists for Units Over 250 MBH
 All AAON Units Are Tested in Accordance With ARI Standards

EER @ ARI Conditions:	9.2	EER Compressor Only @ ARI Conditions:	12.0
Application EER @ Op. Conditions:	5.8	Condensing Unit EER @ Op. Conditions:	11.1

Electrical Data

Rating: 460/3/60
 Unit FLA: 481

Minimum Circuit Amp: 492
 Maximum Overcurrent: 500

Motors

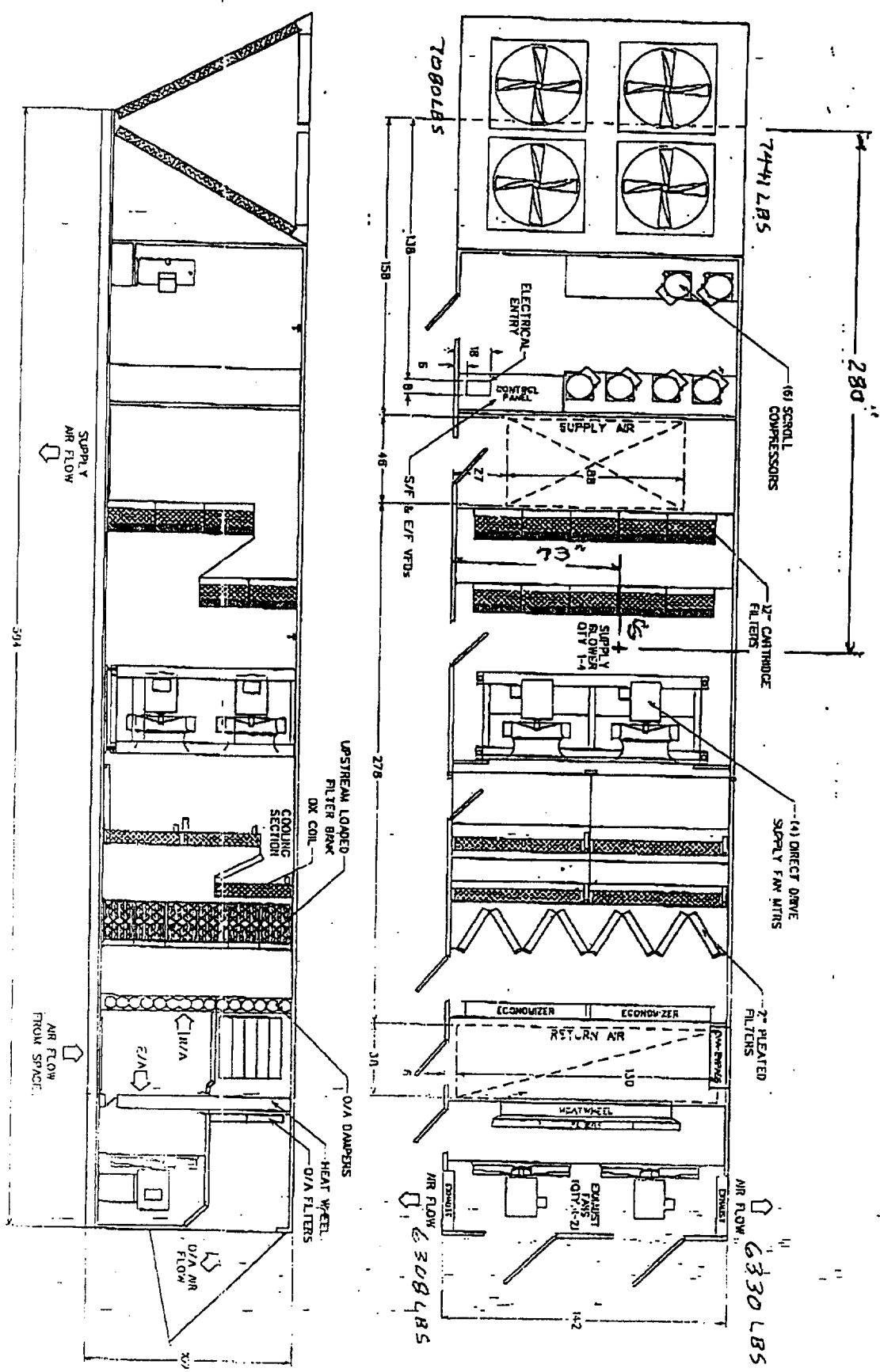
	Qty	HP	VAC	Phase	RPM	FLA	RLA
Compressor 1:	2		460	3			26.98
Compressor 2:	4		460	3			48.15
Condenser Fan:	5	5.00	460	3	1170	7.3	
Supply Fan:	4	25.00	460	3	1760	34.0	
Exhaust Fan:	2	25.00	460	3	1760	34.0	
Heatwheel:	1	0.25	250	1	1760	0.0	

Cabinet Sound Power Levels*

Octave Bands:	83	125	250	500	1000	2000	4000	8000
Discharge LW(dB):	100	99	99	101	99	97	92	85
Return LW(dB):	98	91	85	77	67	67	72	74

*Sound power levels are given for informational purposes only. The sound levels are not guaranteed.

RL155
DX COOLING, NO HEAT
HEAT RECOVERY
95% CARTRIDGE FILTERS



07-0440



REDEMPTION COUPON

Nº: 778-2306

.315**SPECIAL MULTIPLIER DISCOUNT****FOR****RL ROOFTOP UNITS****Issued To:****Rich Nalevanko****Tobey-Karg Sales Agency
Pittsburgh, PA****Job Name:***WEIRTOP MEDICAL***Signature:***Bill A. Adair***Date:** 11/16/01**Coupon Expires: December 31, 2002**

This coupon is valid for eligible AAON sales representatives only and may be used ONE TIME for this specific product group. To use this coupon, it MUST BE SIGNED, DATED and redeemed ONLY by the sales representative to whom it was issued. This coupon IS NOT TRANSFERABLE and has no value if the Salesperson or Sales Representative Office no longer represents AAON, Inc. Redemption is subject to all AAON Standard Terms and Conditions as well as the Terms and Conditions listed on the reverse side of this coupon that are applicable to this program.

SOI Tracking Form

Sales

MUST BE COMPLETE BY:

11/14/01

SOLD TO: FOLEY/KARG JOB NAME: _____
 AAON CONTACT: _____ REQUESTED SHIP DATE: 3/11/02 (4)
 DSO NUMBER: _____ PROJECTED SHIP DATE: 11/14/01
 COMMENTS: _____

Engineering

MUST BE COMPLETE BY:

SOI REQUIRED?: ☐ YES ☐ NO
 AEN / ECN No.: ☐ N/A
 BILL WORK REQ. ON STD. BILLS?: ☐ YES ☐ NO
 ALL UNITS CONFIGURED?: ☐ YES ☐ NO
 WIRING DIAGRAMS COMPLETE?: ☐ YES ☐ NO
 SPECIAL NAMEPLATE INFORMATION: ☐ YES ☐ NO
 SPECIAL ORDER PARTS REQ.?: ☐ YES ☐ NO
 AGENCY APPROVED?: ☐ YES ☐ NO
 IF NO AGENCY APPROVAL, EXPLAIN: _____

COMMENTS: _____
 PREPARED BY: _____ DATE GIVEN TO PROD. / INV. CNTL: _____

Production / Inventory Control

MUST BE COMPLETE BY:

SPECIAL PARTS ON ORDER?: ☐ YES ☐ NO
 SPECIAL BILL WORK COMPLETE?: ☐ YES ☐ NO
 ALL WORK ORDERS ENTERED?: ☐ YES ☐ NO
 PREPARED BY: _____
 SOI INFO. CORRECT TO ENTER?: ☐ YES ☐ NO
 COST ROLL-UP COMPLETE?: ☐ YES ☐ NO
 DATE GIVEN TO MANUFACTURING?: _____
 DATE GIVEN TO SALES: _____

Manufacturing

MUST BE COMPLETE BY:

SOI COMPLETE?: ☐ YES ☐ NO
 NAMEPLATE INFO COMPLETE?: ☐ YES ☐ NO
 COMMENTS: _____
 WIRING DIAGRAM COMPLETE?: ☐ YES ☐ NO
 SPECIAL INSTRUCTIONS COMPLETE?: ☐ YES ☐ NO
 PREPARED BY: _____ DATE GIVEN TO PROD. / INV. CNTL: _____

SPECIAL COMMENTS: _____

AAON, Inc.

Memorandum
via Datafax

To: Creed Hess
Tobey Karg

From: Jim Parro



Date: November 19, 2001

Subject: RL Selection for Weirton Medical Center

cc: B. Pohl
D. Schwartz
M. Roark

R. Schoonover
S. Hammoud

B. Smith
D. Knebel

Confirming our telephone conversation today, I review the following.

We have received and will be entering the subject order for 2 of the RL-155s. As I mentioned to you, we will be adding the net freight amount to the order of \$4608.

Program Error to be Corrected

While you were using the new program, you were able to key the state name directly as "W. Va." rather than using the dropdown box to point and click on "WV".

This disabled the automatic calculation of the freight amount and your printout that was sent to us indicated Zero \$ for freight.

ch111901.doc

CL 347

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SUNON

Page 1 of 2

Sunon Group, Taiwan

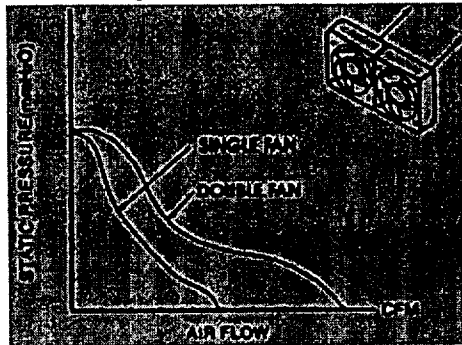
Technology

The Parallel and Series Operation

BACK 

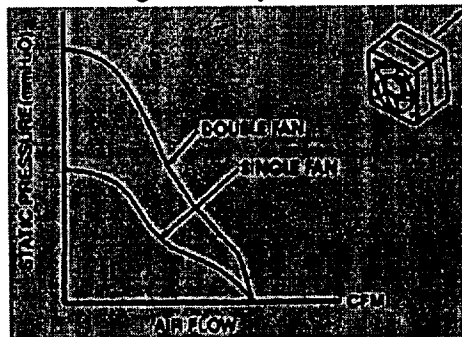
The parallel operation is defined as using two or more fans side by side.

The Operation of Parallel Fans vs. Single Fan Graphs



The volume air flow of two fans in parallel will be double in the free-air condition only. If the parallel fans are applied to the higher system resistance situation, the high system resistance that enclosure has, the less increase in flow results with parallel fan operation. Thus, this type of application is only recommended for the low system resistance situation -- when the fans can operate near free delivery.

The Performance of Series Fan vs. Single Fan Graphs



The series operation is defined as using two or more fans in series.

The static pressure capacity of two fans in series can be doubled at zero air flow condition, but do not increase the airflow in the free-air situation. An additional fan in series increases the volume flow in a higher static pressure enclosure. Thus, in series operation, the best results are achieved in systems with high resistance.

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Current Article: Series and parallel fans.

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Series and parallel fans.

Machine Design; January 26, 1995;

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Machine Design

January 26, 1995

Using two or more fans in series or parallel may be a better alternative than a larger fan. First of all, two identical fans are usually less noisy than a single larger unit. Secondly, depending upon arrangement, either static pressure or airflow may be increased while keeping the other parameter near constant. When two fans work side by side, for example, airflow should double at free delivery. However, the higher the system impedance to flow, the lower the flow increase from the second fan. Hence, a parallel arrangement is recommended when the fans operate in low impedance near free delivery. When one fan pushes air into an enclosure and another pulls air out, the fans are in series. Best results from using fans in series are in systems with high impedance. In both series and parallel operation, especially with more than three fans, some areas of the combined performance curve are unstable and should be avoided. However, the instability is unpredictable because it res...

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ebmpapst

Using fans in series and parallel: performance guidelines

Ian McLeod, Engineering Director, Papst plc

When a single fan within a system cannot deliver sufficient airflow to provide the required level of cooling, and the physical size of the enclosure precludes the use of a larger fan, the concept of mounting fans in series or parallel is sometimes considered. In practice however, the only circumstances in which two fans of equal size can provide double the airflow is when they are operating in free air, i.e. no back pressure to restrict the airflow. This is a theoretical situation not found in practice.

The following article examines what really happens and how the performance of multiple fan solutions can be optimised.

Before examining the performance of series and parallel fan arrangements, it is worth considering the basic concepts of airflow characteristics in practical applications.

Fans are used to produce turbulent air currents which when forced through equipment enclosures, collect and remove heat from the internal components. Physical obstructions to this airflow not only provide a reverse pressure, which the fan must overcome, but can also mask components from the cooling air stream. The enclosure designer must therefore consider the cooling paths when the layout is being decided.

Densely packed enclosures exhibit airflow resistance, manifested as pressure loss in the direction of airflow. It's analogous to an electrical generator forcing current through a resistor - the resistor restricts the current flow.

In theory, weighting factors can be applied to determine the flow/pressure characteristics of systems. In practice, the variety of designs used in enclosures and the presence of internal cards, disk drives, power supplies or other elements that interfere with airflow, mean that it is impossible to calculate weighting factors using general formulae. Designers must rely on measurements or rough approximations.

For practical purposes, the pressure loss of an enclosure, Δp , is approximated by the formula:

$$\Delta p = R_v \times Q/2 \times V^2$$

where R_v is a weighting factor for pressure loss in dimensions of m^{-4} , Q is the density of the displacement medium and V is the velocity of air flow through the system. It can be seen that pressure loss increases as the square of flow rate.

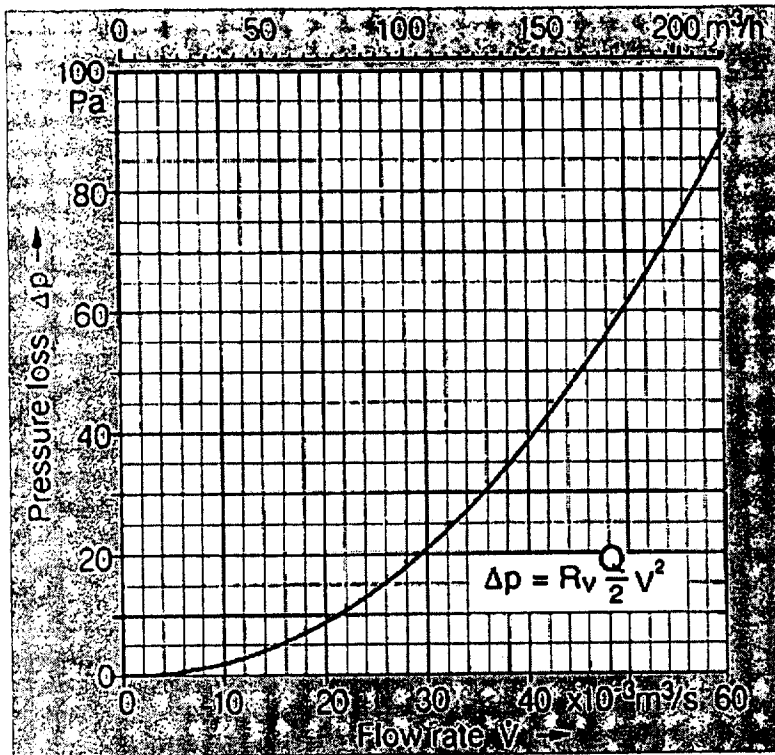
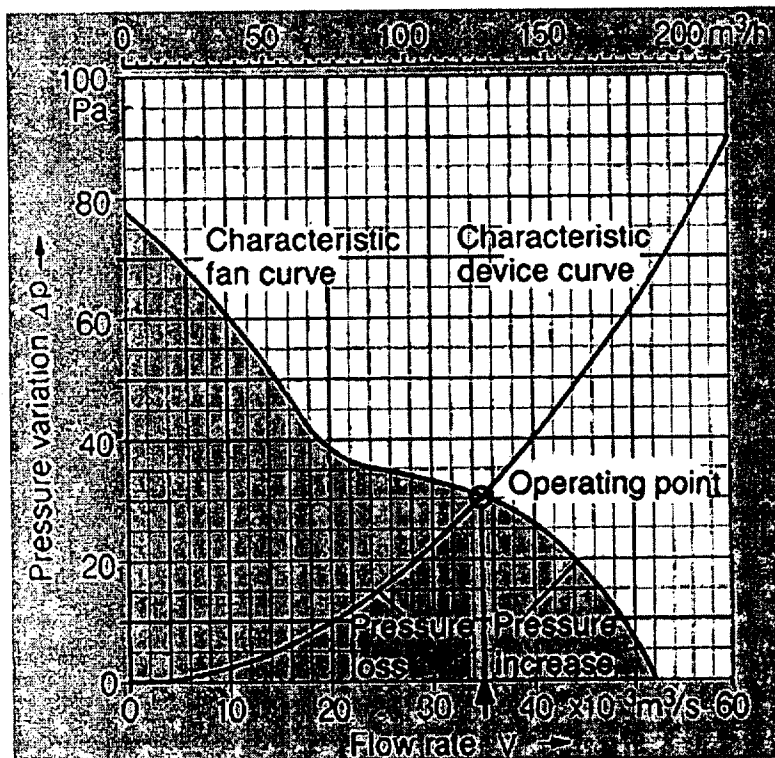


Figure 1 (above) shows the characteristic curve based on this formula where pressure loss is plotted as a function of flow rate. It describes the air flow characteristics of a given enclosure or other system.

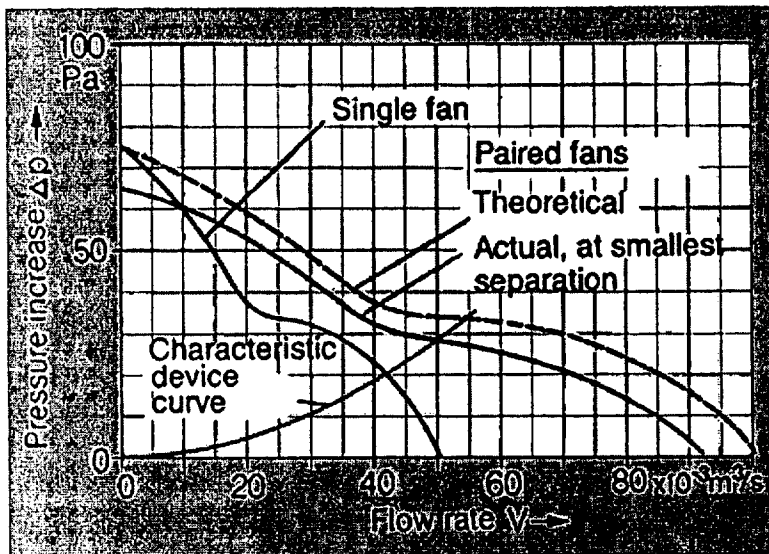


Fans operating in free air generate the maximum possible flow rates, but when fitted within an enclosure the fan is required to overcome the inherent airflow resistance. In order to achieve this the fan needs to produce a pressure increase which will in turn decrease the flow rate. A characteristic fan curve, as shown in Figure 2 (above),

expresses the relationship between flow rate and pressure.

For a given enclosure and fan, the operating point of the fan is determined by the point at which the characteristic enclosure curve and characteristic fan curve intersect. At this point, the pressure loss of the enclosure is just compensated by the pressure increase of the fan and this point determines the flow rate that is available within that enclosure.

With parallel - side by side - mounting, the flow rate is multiplied by the number of fans but the results must be plotted over the entire characteristic fan curve. If fans are placed too close together, other interference effects come into play and reduce the overall flow. This is largely because the flow of air into a fan is usually laminar and smooth, while the exhausted air is much more turbulent. Even in an ideal environment, where interference effects could be ignored, a pressure increase of four times would be needed to produce a doubling of air flow, as pressure loss increases with the square of flow rate. These differences and the effect of using fans in parallel are shown in Figure 3 (below). Here, the airflow only increases by approximately 20 to 25% over that achieved with a single fan.



When fans are mounted in series - one in front of the other - the pressure increase, in theory, is doubled. However, if the fans are close together, results will again fall short of the theoretical performance due to the angular component of airflow introduced in the exhaust of the rear fan. This limits the suction effectiveness of the front fan. One solution is to direct the angular component back into the main air current using guide vanes, but this is a rather inelegant and space-hungry solution. A more commonly adopted and balanced approach is to use one fan on the intake and one on the exhaust side of the enclosure or cabinet. The presence of internal components and the large cross-sectional area between the individual fans will mean that airflow is essentially unidirectional. This provides effective airflow and relatively low noise levels.

The choice of series or parallel fan combinations will clearly depend on the individual application. Some solutions may even require a combination of both techniques. The key point to remember is that two fans never mean twice the air flow.

ebm-Papst Automotive and Drives (UK) Ltd
East Portway
Andover, Hampshire
SP10 3RT

Tel: 01264 333388
Fax: 01264 332182
Email: A&Dsales@uk.ebmpapst.com

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Technical Bulletin CLEANPAK M/R/PF Multi/Redundant/Plenum Fan

The application of multiple fans in a common system, in part, provided the impetus of the design of the "plug" fan years ago. CLEANPAK International has incorporated multiple fans in common cabinets for several years to provide systems that require redundancy, to meet architectural profile requirements, and for space savings. The arrangements may be vertical up or down flow or horizontal. The notes below apply generally, but often relate to redundancy issues, which is a benefit of multiple fan operation whether a design requirement or not.

General

There are three general arrangements for multiple plenum fan configurations as noted below. Each arrangement has its benefits.

1+1: 2 fans can be provided in a cabinet with either fan capable of supplying 100% of the design flow requirement. This would provide 100% redundancy. Normal operation can be simultaneous or independent.

Twin: 2 fans can be provided in a cabinet with both fans required for the design flow. This arrangement provides capacity in excess of 50% if a single fan fails, since the system pressure drop falls by the square root of the volume decrease. Additional capacity can be provided by ramping the VFD up to the limit of the motor full load amps. Normal operation is always simultaneous.

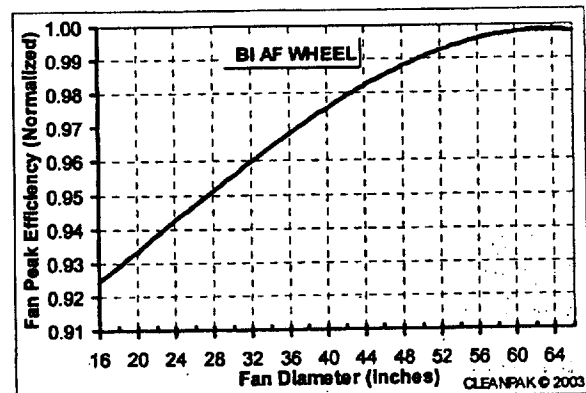
Xn+1: This system provides a measure of redundancy by providing a number of fans smaller than that required by the 1+1 arrangement. The failure of a single fan is accommodated by the initiation of an unused fan, or the ramp up of all remaining fans. The number of fans can be as high as 12-18, although it is not limited. Normal operation is always simultaneous.

Airflow Isolation

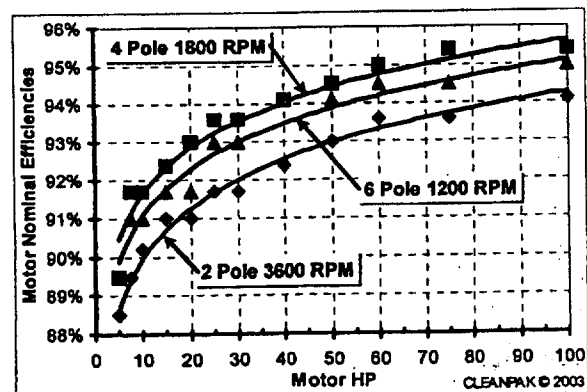
- Inlet or discharge isolation dampers with a solid dividing wall can be provided for fan service of an inoperative fan while operating at design flow for the 1+1 system. The damper pressure drop should be included in the calculation of the total static pressure (TSP).
- An Econo-Disk® may be provided for manual or automatic fan isolation for any of the applications, although as the fans become smaller (18" and under) performance penalties may result. Econo-Disk shutoff characteristics are excellent.
- Inlet isolation dampers can be provided and function similar to, but not as efficiently as, the Econo-Disk. Back draft dampers (heavy duty) can be used but may provide unstable operation at low flows. The damper pressure drop should be included in TSP calculations.
- If some sort of fan isolation is not provided, system performance will suffer a dramatic decrease with a fan failure, due to back flow through the failed fan.

Efficiency

- Larger diameter fans have significantly higher peak efficiencies than smaller diameter fans. Selecting fans at optimum efficiency for an operating point requires the ability to vary wheel width and operating speed.
- Larger motors are significantly more efficient than smaller motors.
- Motors operated at 75% full load are slightly more efficient than those that operate at 100% full load.



Fan efficiencies are generally higher for larger size fans



Motor efficiencies are higher for larger size motors



Technical Bulletin CLEANPAK M/R/PF Multi/Redundant/Plenum Fan

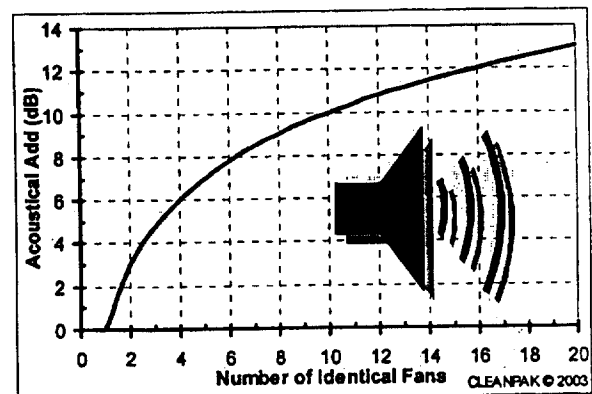
- System efficiency can be improved with internal and external pressure loss reductions such as low velocity coils and high capacity filters.

Dimensions

- For 1+1 systems, inlet and discharge plenum lengths may depend on the normal operating condition. Multiple fan configurations allow for more even velocity profiles for any given length than a single fan configuration.
- Larger fans take more airway length than smaller fans. Service access behind fans is similar for both large and small fans.
- Isolation dampers on the fan inlet increase the airway length.
- Isolation dampers on the fan outlet increase the airway length.
- Large numbers of fans operating as in X_n+1 can reduce the airway length compared to the 1+1 arrangement, particularly if the 1+1 design has an independent operating design rather than a simultaneous operating design.
- Unusual profiles may be accommodated with larger numbers of fans (X_n+1).

Pressure/Volume Control

- VFDs work well when the system follows the fan laws but do not work well if volume varies but the ESP is high and constant, or the fans operate with multiple volumes and constant pressure.
- The Econo-Disk can be used to provide volume control while maintaining design pressure with the simultaneous operation described in 1+1.
- Econo-Disks can be used for both volume and pressure control with manual, pneumatic, or electric actuation.
- Econo-Disks can be used with VFDs for increased flexibility and efficiency.
- Multiple fans such as X_n+1 can be staged and manipulated with VFDs and isolation dampers to offer constant pressure with variable volume.
- Multiple, simultaneous operating fans are generally operated at the same speed.
- Inlet isolation dampers can be used for volume control by "riding the curve" although this is not recommended since it is an inefficient method and may result in unstable operation.



Acoustical add for multiple sources

Sound

- Manufacturers' bare fan sound levels should be adjusted for multiple fan operation. Sound power levels are 11dB higher for 12 fans operating than for only one of the twelve.
- Smaller fans operate at higher speeds than larger fans for any given pressure. This shifts the primary tone of the fan (or blade passage frequency) to higher frequencies and may shift it to a higher octave band. Generally speaking this is advantageous in that higher frequencies are typically attenuated more easily.
- There is a potential for acoustical beats to arise with multiple fan systems.

Vibration Isolation

- 1+1 and twin fan operations are usually internally spring isolated.
- X_n+1 systems with stacked fans, racked, are usually provided without internal isolation, but can be internally spring isolated.

Service

- Smaller fans and motors are easier to physically manipulate than large fans and motors.



Technical Bulletin CLEANPAK M/R/PF Multi/Redundant/Plenum Fan

- Larger numbers of fans, motors, VFDs, dampers, and damper actuators increase service requirements and increase the potential points of failure.
- Generally a fan will be isolated until a system shutdown for major service, or if the fans are screened service is performed while one or more fans are operating.
- Service in an active air stream, without pressure and flow interference can be performed most easily with an airlock.
- Taperlock fan hubs offer quicker and simpler motor/fan wheel replacements than straight bore hubs.
- Bearing life is unaffected by the number of fans operating (1+1 or X_n+1), as the fewer fans use larger motors and bearings and operate at slower speeds.
- Aluminum wheels reduce the bearing load.
- Spare parts are less costly for small fans compared to larger fans.

Electrical

- 100% redundancy systems (1+1) require greater electrical service requirements than other systems but are as efficient or more efficient during operation.
- If single VFDs are used to run multiple motors, each motor requires separate overload protection. VFD to motor lead length is the sum of all the lead lengths fed by a single VFD.
- Multiple VFDs reduce the need for VFD bypass options.

Initial Cost

- \$/CFM are lower for larger fans.
- \$/HP are lower for larger motors and VFDs.
- Cabinet costs may be reduced with X_n+1 systems, due to the reduced cabinet length.

In the application of multiple smaller fans, one should consider several factors that affect initial cost, operating efficiency, redundancy, and reliability. The discussion above should help the designer evaluate the various options. Optimizing for single or multiple fan applications calls for flexibility from the air handling unit manufacturer. Please contact CLEANPAK's technical staff for further information and assistance with your application.

READ AND SAVE THESE INSTRUCTIONS

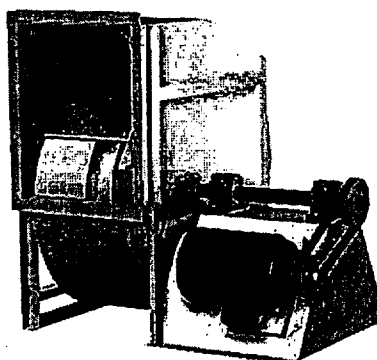
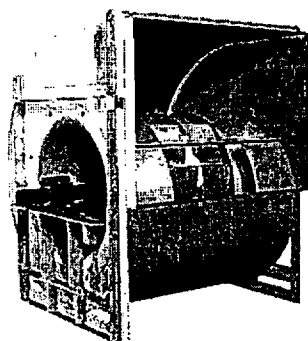
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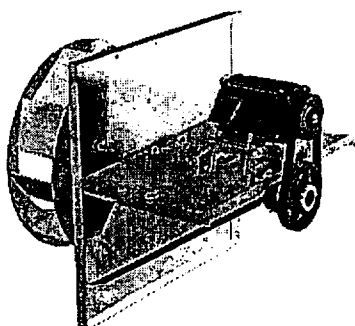
BELT DRIVE

- CENTRIFUGAL (BISW, AFSW, BIDW, AFDW)
- INDUSTRIAL PROCESS (IPA, IPO, IPW)
- PLENUM (QEP)
- PLUG (PLG)

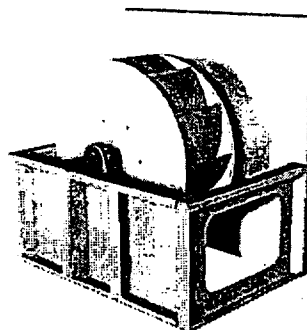
Installation Operating and Maintenance Manual



CENTRIFUGAL AND INDUSTRIAL



PLUG



PLENUM

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Report any damaged equipment to the shipper immediately!

All Centrifugal, Industrial Process, Plenum and Plug Fans are shipped on a skid or packaged to minimize damage during shipment. The transporting carrier has the responsibility for delivering all items in their original condition as received from Greenheck. The individual receiving the equipment is responsible for inspecting the unit for obvious or hidden damage, recording any damage on the bill of lading before acceptance and filing a claim (if required) with the final carrier.

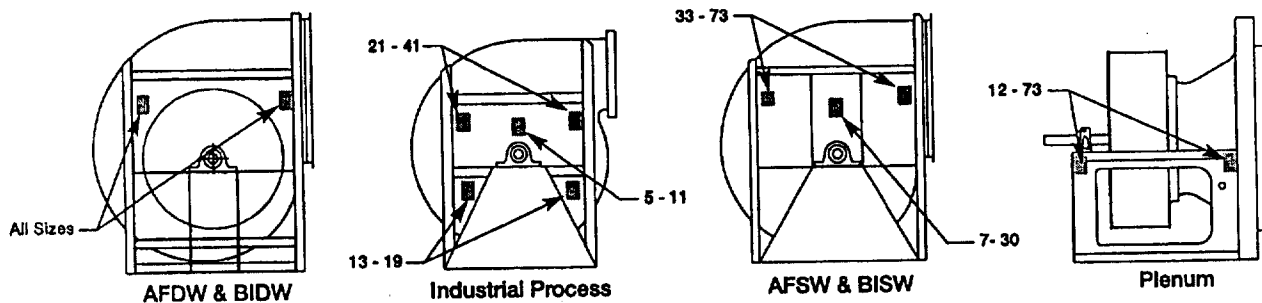
GENERAL INFORMATION

To insure a successful installation, the instructions in this manual should be read and adhered to. Failure to comply with proper installation procedures may void the warranty.

HANDLING

Fans are to be rigged and moved by the lifting brackets provided or by the skid when a forklift is used. See figures below for proper lifting locations. Location of brackets varies by model and size. QEP plenum fans utilize holes located in the framework of the fan. Handle in such a manner as to keep from scratching or chipping the coating. Damaged finish may reduce ability of fan to resist corrosion.

FANS SHOULD NEVER BE LIFTED BY THE SHAFT, HOUSING, MOTOR, BELT GUARD OR ACCESSORIES.



STORAGE

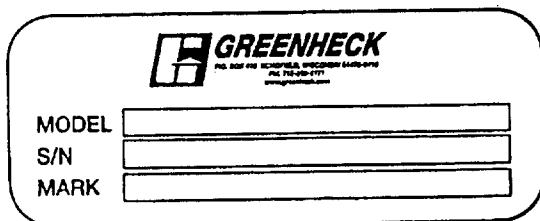
When a fan is not going to be in service for an extended amount of time, certain procedures should be followed to keep the fan in proper operating condition.

- Rotate fan wheel monthly and purge bearings once every three months
- Cover unit with tarp to protect from dirt and moisture (Note: do not use a black tarp as this will promote condensation)
- Energize fan motor once every three months
- Store belts flat to keep them from warping and stretching
- Store unit in location which does not have vibration
- After storage period, purge grease before putting fan into service

If storage of fan is in a humid, dusty or corrosive atmosphere, rotate the fan and purge the bearings once a month. Improper storage which results in damage to the fan will void the warranty.

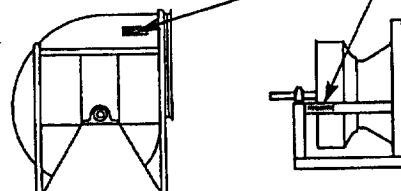
UNIT IDENTIFICATION

The tag below is an example of an identification label on the fan. The information provides general details about the fan, as well as containing specific information unique to the unit. When contacting your Greenheck representative with future needs or questions, please have the information on this label available.



Tags are mounted in an area which is clearly visible, usually near the fan outlet on the drive side of the fan. The exact tag location may differ due fan model and size.

Typical mounting locations for identifying tags



- Model - General description of fan
- S/N - Serial Number assigned by Greenheck, which is a unique identifier for every unit
- Mark - Customer supplied identification

CAUTION!

When installing a fan, ensure the proper protective devices are used to protect personnel from moving parts and other hazards. A complete line of protective accessories are available from Greenheck including: inlet guards, outlet guards, belt guards, shaft guards, protective cages and electrical disconnects.

Check local codes to ensure compliance for all protective devices.

For further details on safety practices involving industrial and commercial fans please refer to AMCA Publication 410.

ELECTRICAL DISCONNECTS

All fan motors should have disconnects located in close visual proximity to turn off electrical service. Service disconnects shall be locked out when maintenance is being performed.

MOVING PARTS

All moving parts must have guards to protect personnel. Refer to local codes for requirements as to the number, type and design. Fully secure fan wheel before performing any maintenance. The fan wheel may start "free wheeling" even if all electrical power has been disconnected. Before the initial start-up or any restart, check the following items to make sure that they are installed and secure.

GUARDS (BELT, SHAFT, INLET, OUTLET)

Do not operate fans without proper protective devices in place. Failure to do so may result in serious bodily injury and property damage.

ACCESS DOORS

Before opening access doors ensure the fan wheel has stopped moving and that the wheel has been secured from being able to rotate. Do not operate fan without access door in its fully closed position.

AIR PRESSURE AND SUCTION

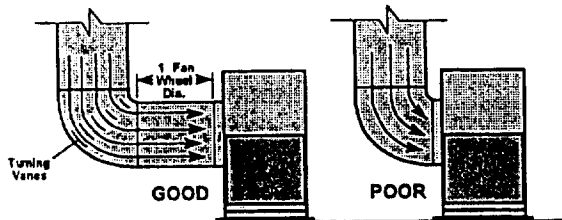
In addition to the usual hazards associated with rotating machinery, fans also create a dangerous suction at the inlet. Special caution needs to be used when moving around a fan whether it is in operation or not. Before start-up, make sure the inlet area is clear of personnel and loose objects.

INSTALLATION

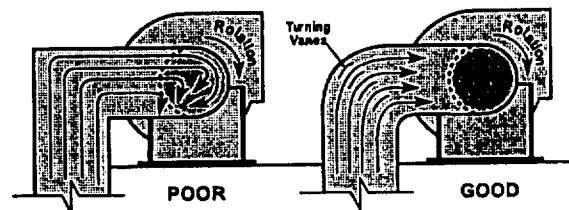
Installations with inlet or discharge configurations that deviate from this standard may result in reduced fan performance. Restricted or unstable flow at the fan inlet can cause pre-rotation of incoming air or uneven loading of the fan wheel yielding large system losses and increased sound levels. Free discharge or turbulent flow in the discharge ductwork will also result in system effect losses. Refer to the following diagrams for the most efficient installation conditions.

CENTRIFUGAL AND INDUSTRIAL PROCESS FANS - INSTALLATIONS**DUCTED INLET INSTALLATIONS****Inlet Duct Turns**

Installation of a duct turn or elbow too close to the fan inlet reduces fan performance because air is loaded unevenly into the fan wheel. To achieve full fan performance, there should be at least one fan wheel diameter between the turn or elbow and the fan inlet.

**Inlet Spin**

Inlet spin is a frequent cause of reduced fan performance. The change in fan performance is a function of the intensity of spin and not easily defined. The best solution is proper duct design and airflow patterns.

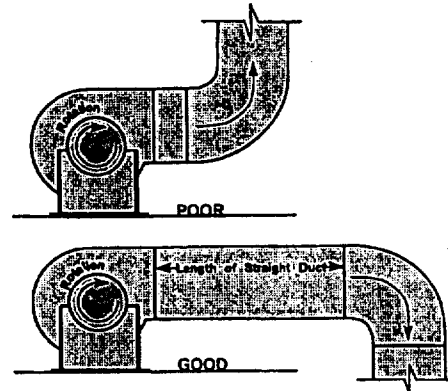


DUCTED OUTLET INSTALLATIONS

Discharge Duct Turns

Duct turns located near the fan discharge should always be in the direction of the fan rotation.

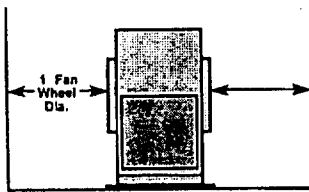
Fan performance is reduced when duct turns are made immediately off the fan discharge. To achieve cataloged fan performance there should be at least three equivalent duct diameters of straight ductwork between the fan discharge and any duct turns.



NON-DUCTED INSTALLATIONS

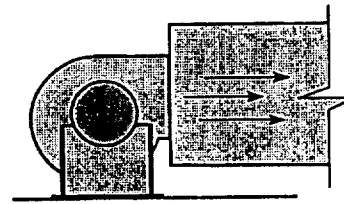
Non-Ducted Inlet Clearance

Installation of a fan with an open inlet too close to a wall or bulkhead will cause reduced fan performance. It is desirable to have one fan wheel diameter and a minimum of three-fourths of a wheel diameter between the fan inlet and the wall.



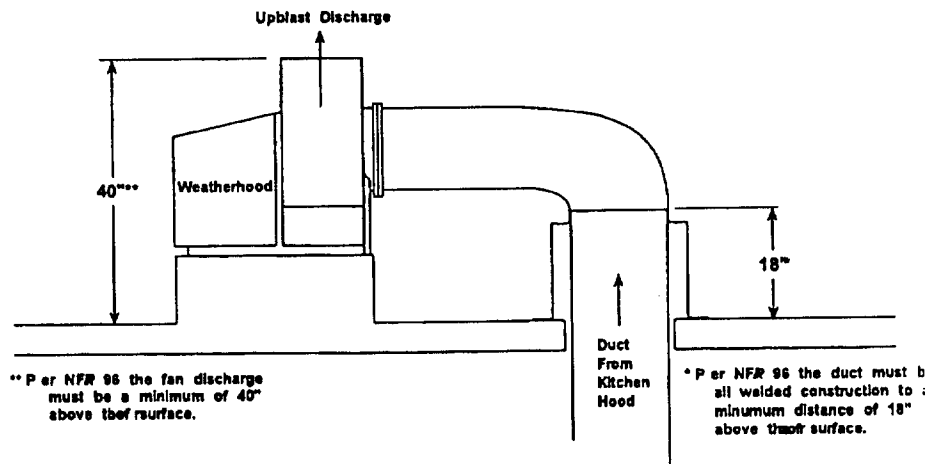
Free Discharge

Free or abrupt discharge into a plenum results in a reduction in fan performance. The effect of static regain in discharge is not realized.



CENTRIFUGAL - Outdoor Installation for UL 762 Listed Fans for Restaurant Exhaust

The UL 762 listing for restaurant exhaust is available on BISW fan sizes 7-73, Arr. 1 and 9 with belt guard and Arr. 10 with weatherhood. UL 762 fans are listed for a maximum operating temperature of 375°F and include a bolted access door and 1" drain connection. An outlet guard is strongly recommended when the fan discharge is accessible. An upblast discharge is recommended. The fan discharge must be a minimum of 40" above the roof line and the exhaust duct must be fully welded to a distance of 18" above the roof surface.



** Per NFPA 96 the fan discharge must be a minimum of 40" above the roof surface.

* Per NFPA 96 the duct must be all welded construction to a minimum distance of 18" above the roof surface.

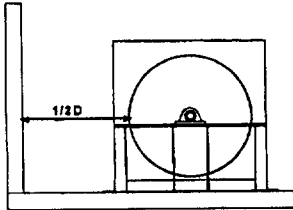
This drawing is for dimensional information only. See the latest edition of NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations for detailed installation instructions, materials, duct connections and clearances.

PLENUM AND PLUG FANS - INSTALLATIONS

UNHOUSED WHEELS

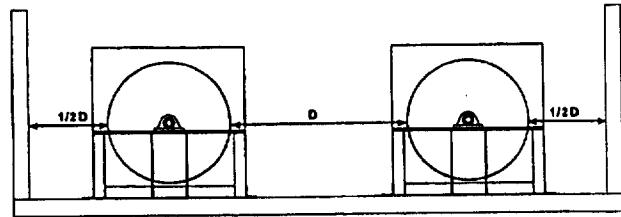
Adjacent Walls

The distance between the fan and walls or ceilings will effect the performance of the fan. The recommended distance between the fan wheel and any wall is a minimum of one - half wheel diameter. Multiple walls reduce the performance even more.



Side by Side

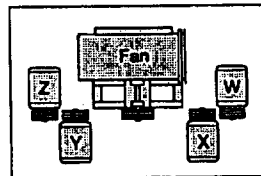
When two or more plenum fans are in parallel, there should be at least one fan diameter spacing between the wheels. Applications with less spacing will experience performance losses.



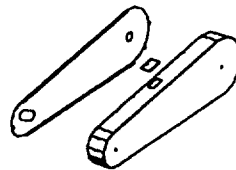
BELT GUARDS

Greenheck offers four types of customized belt guards dependent upon fan model, arrangement and motor position. The four types of belt guards are shown in illustrations to the right.

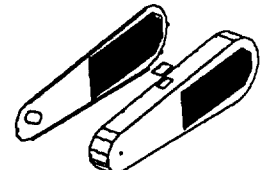
If the guard is not purchased from Greenheck, they must be supplied by the installer or owner.



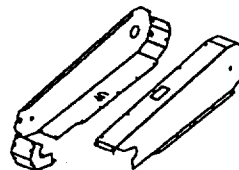
Motor position and fan rotation are determined from drive side



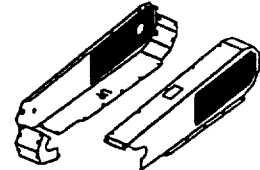
QEP & SW - Arr. 1, 3
(Mtr Pos. W / Z)
SW - Arr. 9, 10
PLG



DW - Arr. 3 (Mtr Pos. W / Z)

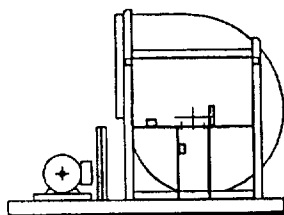


QEP & SW - Arr. 1, 3 (Mtr
Pos. X / Y)

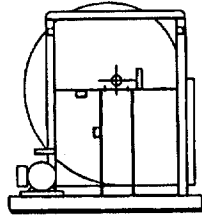


DW - Arr. 3 (Mtr Pos. X / Y)

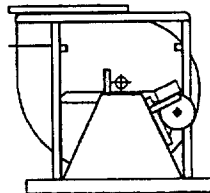
If the belt guard is not factory mounted or was not supplied by Greenheck, then it must be field mounted. **Brackets and mounting hardware are the responsibility of the installer.** The figures below illustrate suggested attachment points for belt guard mounting bracket locations. These locations vary with motor mounting position, arrangement, and fan type. The bearing supports and fan structure are used in most instances and when the motor is not mounted to the fan itself, a bracket should also be located near it. This information is intended as only a guide and actual field conditions may dictate another mounting location for the guard brackets. Refer to local codes for securing guarding.



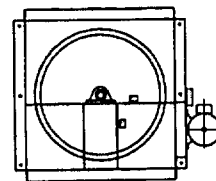
Mtr. Position: W/Z
Arr. - 1,3



Mtr. Position: X/Y
Arr. - 1,3



Mtr. Position: L/R
Arr. - 9



Mtr. Position: Side

Suggested Attachment Points

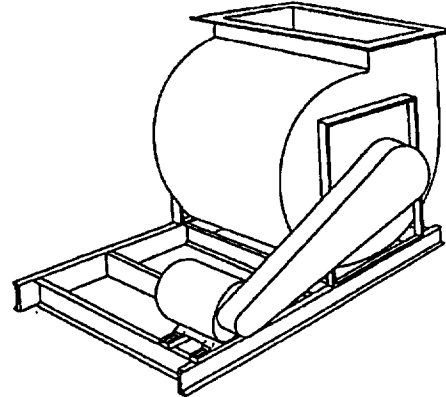
BASES

(FOUNDATION AND ISOLATION)

Critical to every fan installation is a strong, level foundation. A reinforced poured concrete pad with a structural steel base or inertia base provides an excellent foundation. Structural bases must be sturdy enough, with welded construction, to prevent flexing and vibration.

To eliminate vibration and noise from being transferred to the building, vibration isolators should be used. The fan is mounted directly on the isolation base and must be supported the entire length of the fan base angle (Refer to the installation manual for structural bases if the base was supplied by Greenheck). The isolators are installed between the isolation base and the foundation.

After the fan, isolation base, and isolators are installed, the entire assembly must be leveled. Position the level on the isolation base, not the fan shaft, for proper leveling. Additionally, the motor and fan shafts must be level and parallel relative to each other for proper alignment.



Typical Fan on Isolation Base

ROTATABLE HOUSINGS

It may be necessary to rotate the scroll of the fan to achieve a different discharge position than what was originally supplied. Centrifugal fans models BISW, AFSW, BIDW, and AFDW (sizes 7 - 30, arr. 1, 9, and 10, class I and II) and Industrial Process fans (sizes 5 - 19, standard and heavy duty) have the flexibility to be rotated in the field. This is accomplished by removing the housing bolts, rotating the housing to a new discharge position, and reinstalling the bolts.

RADIAL GAP, OVERLAP & WHEEL ALIGNMENT

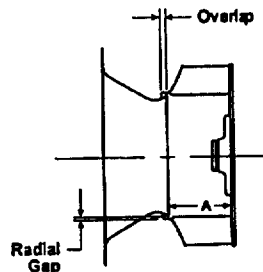
Efficient fan performance can be maintained by having the correct radial gap, overlap and wheel alignment. These items should be checked after the fan has been in operation for 24 hours and before start-up when the unit has been disassembled. Radial gap and overlap information applies to models: BISW, AFSW, BIDW, AFDW, QEP, and PLG.

**Inlet Cone to
Backplate Distance**
not QEP (Inches)

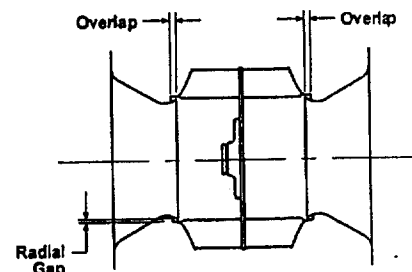
Unit Size	A dim. ± Tolerance
7 - 10	3 5/8 ± 1/8
12	4 ± 1/8
13	4 7/16 ± 1/8
15	5 ± 1/8
16	5 7/16 ± 1/8
18	6 3/8 ± 1/8
20	7 ± 3/16
22	7 13/16 ± 3/16
24	8 5/8 ± 1/4
27	9 7/16 ± 1/4
30	10 9/16 ± 3/8
33	11 7/16 ± 3/8
36	12 3/4 ± 3/8
40	14 3/16 ± 3/8
44	15 9/16 ± 3/8
49	17 1/8 ± 1/2
54	18 13/16 ± 1/2
60	20 15/16 ± 1/2
66	22 7/8 ± 1/2
73	25 1/2 ± 1/2

**QEP Inlet Cone to
Backplate Distance**
(Inches)

Unit Size	A dim. ± Tolerance
12	3 1/2 ± 1/8
15	5 3/8 ± 1/8
16	5 7/8 ± 1/8
18	6 1/2 ± 1/8
20	7 ± 1/8
22	7 7/8 ± 1/8
24	8 5/8 ± 1/8
27	9 1/2 ± 1/8
30	10 5/8 ± 1/8
33	11 3/4 ± 1/8
36	13 ± 1/8
40	14 1/4 ± 1/8
44	15 3/4 ± 1/8
49	17 3/8 ± 1/8
54	19 1/4 ± 1/8
60	21 1/4 ± 1/8
66	23 3/8 ± 1/8
73	25 7/8 ± 1/8



BISW, AFSW, QEP, PLG



BIDW, AFDW

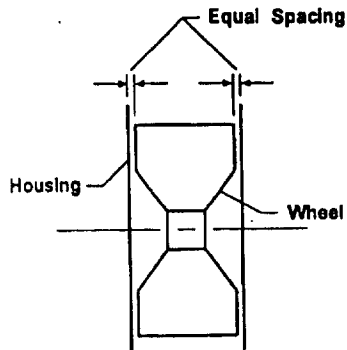
RADIAL GAP

Radial gap is adjusted by loosening the inlet cone/ring bolts and centering the cone/ring on the wheel. If additional adjustment is required to maintain a constant radial gap, loosening the bearing bolts and centering wheel is acceptable as a secondary option.

OVERLAP

Overlap is adjusted by loosening the wheel hub from the shaft and moving the wheel to the desired position along the shaft. The Inlet Cone to Backplate Distance chart lists the distance between the wheel and the Inlet cone spacing for non-double width fans. Overlap on double width fans is set by having equal spacing on each side of the wheel.

WHEEL ALIGNMENT



IPA, IPO, IPW

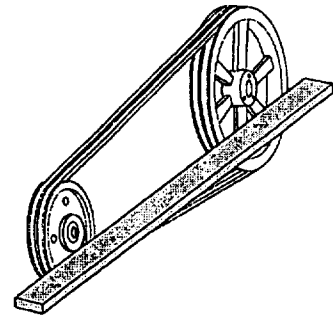
Correct wheel alignment for industrial process fans, models IPA, IPO, and IPW is achieved by centering the wheel in the housing.

V BELT DRIVES

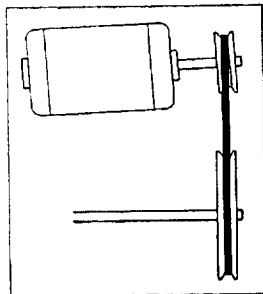
The V-belt drive components, when supplied by Greenheck Fan Corporation, have been carefully selected for this unit's specific operating condition. Caution: changing V-belt drive components could result in unsafe operating conditions which may cause personal injury or failure of the following components: 1. Fan Shaft, 2. Fan Wheel, 3. Bearings, 4. V-belt, 5. Motor.

V BELT DRIVE INSTALLATION

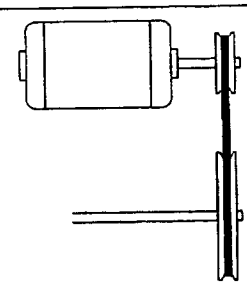
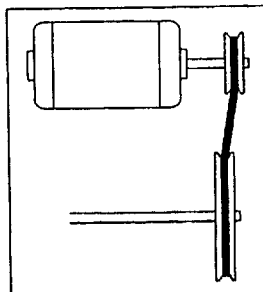
1. Remove the protective coating from the end of the fan shaft and assure that it is free of nicks and burrs.
2. Check fan and motor shafts for parallel and angular alignment.
3. Slide sheaves on shafts - do not drive sheaves on as this may result in bearing damage.
4. Align fan and motor sheaves with a straight-edge or string and tighten.
5. Place belts over sheaves. Do not pry or force belts, as this could result in damage to the cords in the belts.
6. Adjust the tension until the belts appear snug. Run the unit for a few minutes (see section on unit start-up) and allow the belts to "Set" properly.
7. With the fan off, adjust the belt tension by moving the motor base. (See belt tensioning procedures in the maintenance section of this manual). When in operation, the tight side of the belts should be in a straight line from sheave to sheave with a slight bow on the slack side.



Aligning Sheaves with a Straight Edge



Improper Sheave Alignment



Proper Sheave Alignment

UNIT START UP

1. Disconnect and lock-out all power switches to fan. See warning below.
2. Check all fasteners, set screws and locking collars on the fan, bearings, drive, motor base and accessories for tightness.
3. Rotate the fan wheel by hand and assure no parts are rubbing.
4. Check for bearing alignment and lubrication.
5. Check the V-belt drive for proper alignment and tension.
6. Check the all guarding (if supplied) for being securely attached and not interfering with rotating parts.
7. Check operation of variable inlet vanes or discharge dampers (if supplied) for freedom of movement.
8. Check all electrical connections for proper attachment.
9. Check housing and ductwork, if accessible, for obstructions and foreign material that may damage the fan wheel.

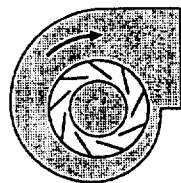
WARNING

Disconnect and secure to the "Off" position all electrical power to the fan prior to inspection or servicing. Failure to comply with this safety precaution could result in serious injury or death.

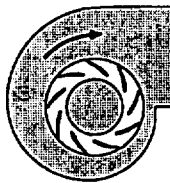
ADDITIONAL STEPS FOR INITIAL START-UP

1. Check for proper wheel rotation by momentarily energizing the fan. Rotation is always determined by viewing the wheel from the drive side and should correspond to the rotation decal affixed to the unit. One of the most frequently encountered problems with Centrifugal Fans is motors which are wired to run in the wrong direction. This is especially true with 3-phase installations where the motor will run in either direction, depending on how it has been wired. To reverse rotation of a 3-phase motor, interchange any two of the three electrical leads. Single phase motors can be reversed by changing internal connections as described on the motor label or wiring diagram.

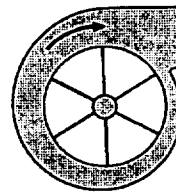
CW ROTATION



Centrifugal
Backward Inclined



Centrifugal
Airfoil



Industrial Process
Radial Blade

Always viewed from the drive side.

2. If the fan has inlet vanes, they should be partially closed to reduce power requirements. This is especially important if the fan is designed for a high temperature application and is being started at room temperature.
3. Fans with multi-speed motors should be checked on low speed during initial start-up.
4. Check for unusual noise, vibration or overheating of bearings. Refer to the "Troubleshooting" section of this manual if a problem develops.
5. Grease may be forced out of the bearing seals during initial start-up. This is a normal self-purging feature of this type of bearing.

VIBRATION

Excessive vibration is the most frequent problem experienced during initial start-up. Left unchecked, excessive vibration can cause a multitude of problems, including structural and/or component failure. The most common sources of vibration are listed below.

1. Wheel Unbalance
2. Drive Pulley Misalignment
3. Incorrect Belt Tension
4. Bearing Misalignment
5. Mechanical Looseness
6. Faulty Belts
7. Drive Component Unbalance
8. Poor Inlet/Outlet Conditions
9. Foundation Stiffness

Many of these conditions can be discovered by careful observation. Refer to the troubleshooting section of this manual for corrective actions. If observation cannot locate the source of vibration, a qualified technician using vibration analysis equipment should be consulted. If the problem is wheel unbalance, in-place balancing can be done providing there is access to the fan wheel. Any correction weights added to the wheel should be welded to either the wheel back (single plane balance) or to the wheel back and wheel cone (two-plane balance).

Greenheck performs a vibration test on all centrifugal fans before shipping. Three vibration readings are taken on each bearing in the horizontal, vertical, and axial directions. The allowable maximum vibration is 0.15 in/sec. peak velocity filter-in at the fan rpm per AMCA standard 204. These vibration signatures are a permanent record of how the fan left the factory and are available upon request.

Generally, fan vibration and noise is transmitted to other parts of the building by the ductwork. To eliminate this undesirable effect, the use of heavy canvas connectors is recommended. If fireproof material is required, Flexweave 1000 - type FN-30 can be used.

ROUTINE MAINTENANCE

Once the unit has been put into operation, a routine maintenance schedule should be set up to accomplish the following:

1. Lubrication of bearings and motor.
2. Variable inlet vanes should be checked for freedom of operation and wear.
3. Wheel, housing, bolts and set screws on the entire fan should be checked for tightness.
4. Any dirt accumulation on the wheel or in the housing should be removed to prevent unbalance and possible damage.
5. Isolation bases should be checked for freedom of movement and the bolts for tightness. Springs should be checked for breaks and fatigue. Rubber isolators should be checked for deterioration.
6. Inspect fan impeller and housing looking for fatigue, corrosion, or wear.

When performing any service to the fan, disconnect the electrical supply and secure fan impeller.

CAUTION:

When operating conditions of the fan are to be changed (speed, pressure, temperature, etc.) consult Greenheck to determine if the unit can operate safely at the new conditions.

MOTORS

Motor maintenance is generally limited to cleaning and lubrication. Cleaning should be limited to exterior surfaces only. Removing dust and grease buildup on the motor housing assists proper motor cooling. Never wash-down motor with high pressure spray. Greasing of motors is only intended when fittings are provided. Many fractional motors are permanently lubricated for life and require no further lubrication. Motors supplied with grease fittings should be greased in accordance with the manufacturer's recommendations. When motor temperature does not exceed 104°F (40°C), the grease should be replaced after 2000 hours of running time.

BEARINGS

The bearings for Greenheck fans are carefully selected to match the maximum load and operating conditions of the specific class, arrangement, and fan size. The instructions provided in this manual and those provided by the bearing manufacturer, will minimize any bearing problems. Bearings are the most critical moving part of the fan, therefore special care is required when mounting them on the unit and maintaining them.

Refer to the following chart and the manufacturers instructions for grease types and intervals for various operating conditions. Never mix greases made with different bases. This will cause a breakdown of the grease and possible failure of the bearing.

Recommended Bearing Lubrication Schedule for Greenheck Fans								
Relubrication Schedule in Months*								
Fan RPM	Bearing Bore (inches)							
	1/2 - 1	1 1/8 - 1 1/2	1 5/8 - 1 7/8	1 15/16 - 2 3/16	2 7/16 - 3	3 3/16 - 3 1/2	3 15/16 - 4 1/2	4 15/16 - 5 1/2
To 250	6	6	6	6	6	5	4	3
500	6	6	6	6	4	3	3	2
750	6	5	4	3	3	2	2	1
1000	6	4	3	2	2	1	1	0.5
1250	5	3	2	1	1	0.5	0.5	0.25
1500	5	2	1	1	0.5	0.5	0.25	0.25
2000	5	1	1	0.5	0.25	0.25	0.25	0.25
2500	4	0.5	0.5	0.25	0.25	0.25		
3000	4	0.5	0.25	0.25	0.25			
4000	3	0.25	0.25	0.25	0.25			
5000	2	0.25	0.25	0.25				

* Suggested initial greasing interval is based on 12 hour per day operation and 150 degree F. maximum housing temperature. For continuous (24 hour) operation, decrease greasing interval by 50%.

- If possible relubricate with grease while in operation, without endangering personnel.
- For ball bearings (operating) relubricate until clean grease is seen purging at the seals. Be careful not to unseat the seal by over lubricating.
- For ball bearings (idle) add 1-2 shots of grease up to 2" bore sizes, and 4-5 shots of grease above 2" bore sizes with hand grease gun.
- For roller bearings relubricate with 4 shots of grease up to 2" bore size, 8 shots for 2"-5" bore size, and 16 shots above 5" bore size with hand grease gun.
- Adjust lubrication frequency based on condition of purged grease.
- A high quality lithium base grease conforming to NLGI Grade 2 consistency, such as those listed below, should be used.

MOBILITH SHC 220	TEXACO MULTIFAK AFB2	SHELL ALVANIA #2
MOBILITH AW2	TEXACO PREMIUM RB	EXXON UNIREX N2

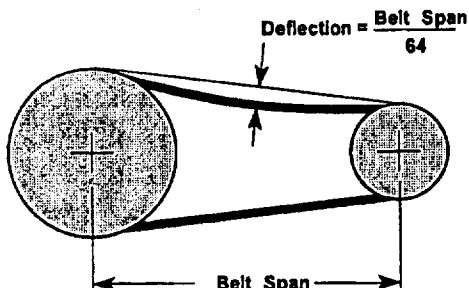
WARNING: Lubricate bearings prior to periods of extended shutdowns or storage and rotate shaft monthly to aid in preventing corrosion. If the fan is stored more than three months, the bearings should be purged with new grease prior to start-up.

V-BELT DRIVES

V-belt drives must be checked on a regular basis for wear, tension, alignment and dirt accumulation. Premature or frequent belt failures can be caused by improper belt tension, (either too loose or too tight) or misaligned sheaves. Abnormally high belt tension or drive misalignment will cause excessive bearing loads and may result in failure of the fan and/or motor bearings. Conversely, loose belts will cause squealing on start-up, excessive belt flutter, slippage, and overheated sheaves. Either excessively loose or tight belts may cause fan vibration.

When replacing V-belts on multiple groove drives all belts should be changed to provide uniform drive loading. Do not pry belts on or off the sheave. Loosen belt tension until belts can be removed by simply lifting the belts off the sheaves. After replacing belts, insure that slack in each belt is on the same side of the drive. Belt dressing should never be used.

Do not install new belts on worn sheaves. If the sheaves have grooves worn in them, they must be replaced before new belts are installed.



The proper tension for operating a V-belt drive is the lowest tension at which the belts will not slip at peak load conditions. For initial tensioning, the proper belt deflection half-way between sheave centers is 1/64" for each inch of belt span. For example, if the belt span is 64 inches, the belt deflection should be 1 inch using moderate thumb pressure at mid-point of the drive. Check belt tension two times during the first 24 hours of operation and periodically thereafter.

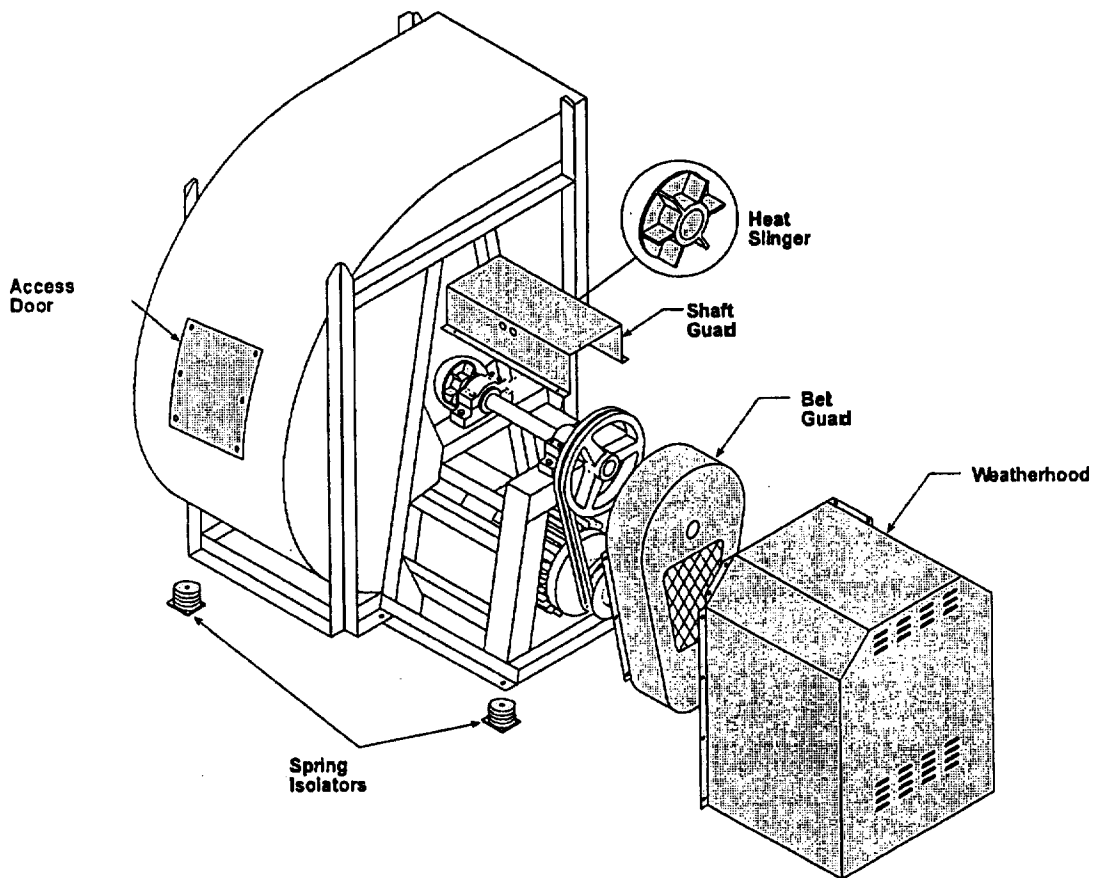
TROUBLESHOOTING

Problem	Cause	Corrective Action
Excessive Noise	Wheel Rubbing Inlet	Adjust wheel and/or inlet cone. Tighten wheel hub or bearing collars on shaft.
	V-Belt Drive	Tighten sheaves on motor/fan shaft. Adjust belt tension. Align sheaves properly (see page 7). Replace worn belts or sheaves.
	Bearings	Replace defective bearing(s). Lubricate bearings. Tighten collars and fasteners.
	Wheel Unbalance	Clean all dirt off wheel. Check wheel balance, rebalance in-place if necessary.
Low CFM	Fan	Check wheel for correct rotation. Increase fan speed.*
	Duct System	See page 3.
High CFM	Fan	Decrease fan speed.
	Duct system	Resize ductwork. Access door, filters, grills not installed.
Static Pressure Wrong	Duct system has more or less restriction than anticipated	Change obstructions in system. Use correction factor to adjust for temperature/altitude. Resize ductwork. Clean filters/coils. Change fan speed.*
High Horsepower	Fan	Check rotation of wheel. Reduce fan speed.
	Duct System	Resize ductwork. Check proper operation of face and bypass dampers. Check filters and access doors.
Fan Doesn't Operate	Electrical Supply	Check fuses/circuit breakers. Check for switches turned off or disconnected. Check for correct supply voltage.
	Drive	Check for broken belts. Tighten loose pulleys.
	Motor	Assure motor is correct horsepower and not tripping overload protector.
Overheated Bearing	Lubrication	Check for excessive or insufficient grease in the bearing.
	Mechanical	Replace damaged bearing. Relieve excessive belt tension. Align bearings. Check for bent shaft.
Excessive Vibration	Belts	Adjust tightness of belts. Replacement belts should be a matched set.
	System Unbalance	Check alignment of shaft, motor and pulleys. Adjustable pitch pulleys with motors over 15 hp motors are especially prone to unbalance. Check wheel balance, rebalance if necessary.

* Always check motor amps and compare to nameplate rating. Excessive fan speed may overload the motor and result in motor failure. Do not exceed the maximum cataloged rpm of the fan.

NOTE: Always provide the unit model and serial numbers when requesting parts or service information.

CENTRIFUGAL / INDUSTRIAL PARTS DRAWING



WARRANTY

Greenheck warrants this equipment to be free from defects in material and workmanship for period of one year from the purchase date. This warranty limits our responsibility to repairing or replacing, to the original purchaser, any part or parts of said equipment found to be defective upon examination by representatives of Greenheck. Additionally, said part or parts will be returned to and received by the factory only after prior authorization, with transportation charges prepaid.

Greenheck shall not be obligated under this warranty, for payment of any delivery, removal or installation charges with regard to repair or replacement of any defective part or parts.

Motors are warranted by the motor manufacturer for a period of one year. Should motors furnished by Greenheck prove defective during this period, they should be returned to the nearest authorized motor service station.



PN 463687 Cent. Belt IOM FS
Rev. 1 October 2003
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DELHI INDUSTRIES INC.

PAGE 1 OF 2

DPL SERIES - DELHI PLENUM FAN INSTALLATION AND MAINTENANCE INSTRUCTIONS

MODELS: DPL-12, DPL-13, DPL-15, DPL-16, DPL-18, DPL-20, DPL-22, DPL-24, DPL-27, DPL-30, DPL-33, DPL-36

Read installation and operation instructions carefully before attempting to install, operate or service DELHI PLENUM FANS. Failure to comply with instructions could result in personal injury and/or property damage. Retain instructions for future reference.

UNPACKING

Once the packaging has been removed inspect the unit carefully. Check for loose, missing, or damaged parts. Rotate the wheel by hand to ensure the wheel spins freely. Tighten all set screws.

Maximum HP Ratings and Shaft Details

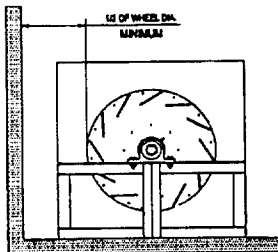
MODEL	DPL-12	DPL-13	DPL-15	DPL-16	DPL-18	DPL-20	DPL-22	DPL-24	DPL-27	DPL-30	DPL-33	DPL-36
SHAFT DIA	1	1	1	1-3/16	1-3/16	1-3/16	1-3/16	1-7/16	1-7/16	1-11/16	1-11/16	1-15/16
MAX RPM	3550	3200	2900	2600	2300	2150	1900	1750	1580	1420	1300	1180
MAX HP	5	5	5	7-1/2	7-1/2	10	10	15	15	20	25	30

GENERAL SAFETY INSTRUCTIONS

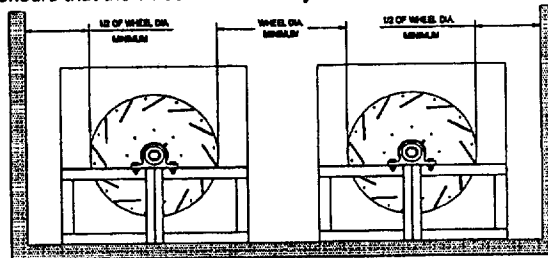
- 1 Always disconnect power source before working on or near a motor or its connected load. Lock the power disconnect in the off position and tag to prevent unauthorized application of power.
- 2 Follow all local and national electrical and safety codes.
- 3 Blower must be electrically grounded. This can be accomplished by using a separate ground wire connected to the bare metal of blower frame, or other suitable means.
- 4 Ensure that the power source conforms to the requirements of your equipment.
- 5 Do not put hands near or allow loose and hanging clothing to be near belts, pulleys, or blower wheel while the unit is running.

INSTALLATION

Mount blower on solid rigid flat base and secure with suitable fasteners through mounting holes provided in the cabinet frame assembly and motor frame assembly (optional). Use optional vibration isolators if required. Ensure that all fasteners are tight and secure. Double check wheel set screw for tightness and ensure that the wheel rotates freely.



ADJACENT PLENUM WALLS



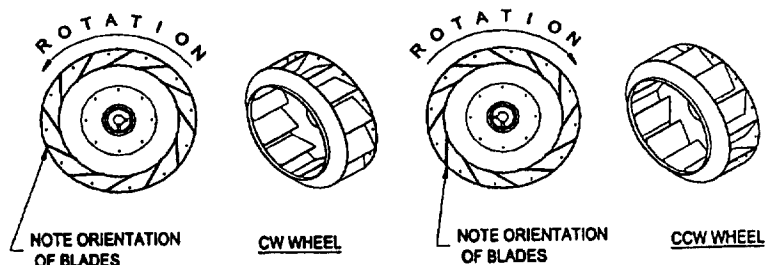
SIDE BY SIDE PLENUM FANS

The distance between the fan and walls or ceilings will effect the performance of the fan. The recommended distance between the fan wheel and any wall is a minimum of one - half wheel diameter. Multiple walls reduce the performance even more. When two or more plenums fans are in parallel, there should be at least one fan diameter spacing between the wheels.

Test the fan to ensure the rotation of the wheel is the same as indicated by the arrow marked Rotation.

Note: Wheel Orientation Nomenclature (CW/CCW) is based upon viewing rotation from the drive side.

The illustrated wheels are shown from inlet side.



DELHI INDUSTRIES INC.

PAGE 2 OF 2

DPL SERIES - DELHI PLENUM FAN INSTALLATION AND MAINTENANCE INSTRUCTIONS

MODELS: DPL-12, DPL-13, DPL-15, DPL-16, DPL-18, DPL-20, DPL-22, DPL-24, DPL-27, DPL-30, DPL-33, DPL-36

BELT TENSION & PULLEY ALIGNMENT

Proper belt tension and alignment is essential for quiet operation and bearing life. Follow illustrated recommendations on belt installation below.

RESILIENT BASE MOUNT MOTORS

With the belt grasped as shown a total deflection of 1" (1/2" on each side) should be easily attained. See figure 1.

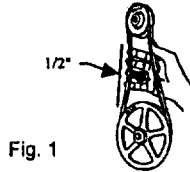
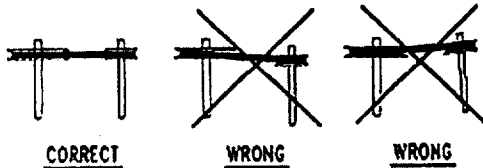


Fig. 1

PULLEY ALIGNMENT

Align pulleys with a straight edge to conserve belt life and eliminate unnecessary noise.

NOTE: Pulley alignment may change when adjusting variable pitch pulleys.



Check tension before start-up, after every pulley adjustment and regularly thereafter.

RIGID BASE MOTORS - GOOD METHOD

Release the tension from the belt ensuring there is no slack. Measure the distance between shaft centres. Release the tension from the belt ensuring there is no slack. Measure the distance between shaft centres. Add 1% to the shaft centre distance and adjust the shaft centres until that value is obtained. Example: The untensioned shaft centres on a model DPL-22 fan measures 25-9/16" Tensioned centres = $25-9/16 \times 1.01 = 25-13/16$ " (1/4" extension). See figure 2.

RIGID BASE MOTORS - BETTER METHOD

Using a tension gauge, apply 4 lbs of force to the centre of the belt and adjust the tension until a deflection of 1/64" for every inch of shaft centre is obtained. See Figure 3.

RIGID BASE MOTORS - PERFECT METHOD

Ideal belt tension is the lowest value under which belt slip will not occur at peak load conditions.

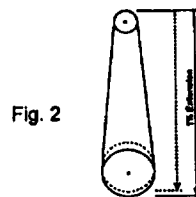


Fig. 2

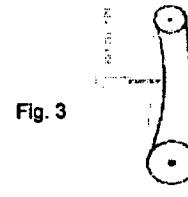


Fig. 3

MODEL	DPL-12	DPL-13	DPL-15	DPL-16	DPL-18	DPL-20	DPL-22	DPL-24	DPL-27	DPL-30	DPL-33	DPL-36
CENTER LINE	15.19	16.19	17.50	18.31	19.75	21.25	23.94	25.69	27.75	29.75	32.06	34.81
DISTANCE FOR	15.94	16.94	18.25	19.13	20.56	22.00	24.19	26.00	28.06	30.00	32.31	35.13
OPTIONAL MOTOR	17.31	18.25	19.50	20.44	21.88	23.31	25.56	27.31	29.38	31.38	33.63	36.44
PLATFORM				21.25	22.69	24.13	26.38	28.13	30.13	32.25	34.50	37.25
							27.56	29.25	31.25	33.38	35.50	38.25
										34.13	36.31	39.00

ELECTRICAL

Connect motor in accordance with applicable codes. Provide properly sized motor overload protection to protect motor against electrical faults and system changes. Confirm proper motor rotation on start-up.

MAINTENANCE

Inspect periodically for mounting rigidity. Verify belt for wear and tension and adjust as required. Inspect wheel for any dust accumulation and clean as indicated.

LUBRICATION

Cast iron, pillow block, sealed type, bearings are used on all DPL PLENUM FANS. Operating temperature range is -30 to 230 deg. F. Re-lubrication is unnecessary under most operating conditions. If re-lubrication is required, lubricant should be compatible to Shell Alvania #2. (Lithium base - Grade 2)